

U.S. Department of Energy, Biomass Program

Presented by: Steve Gorin, National Renewable Energy Laboratory

Growing America's Energy Future

April 6, 2010

NREL's Mission is Unique



- Only national laboratory dedicated to renewable energy and energy efficiency R&D
- Collaboration with industry and university partners is a hallmark
- Ability to link scientific discovery and product development to accelerate commercialization



Alliance for Sustainable Energy—Partnering with Excellence



Battelle
The Business of Innovation



STANFORD
UNIVERSITY



Colorado
State
University®

Colorado
University of Colorado at Boulder

Massachusetts
Institute of
Technology

Why invest in Biomass?



- Biomass is a sustainable and renewable resource that can contribute to nation's long term energy and environment goals
 - Energy Independence and Security Act (EISA) of 2007 and Renewable Fuels Standard (RFS2) goals – 36 billion gallons per year by 2022
 - When fully implemented, in 2022 the RFS2 is expected to reduce GHG emissions by 138 million metric tons – the equivalent of removing 27 million vehicles from the road
- Flexible resource that can be used for fuels, power, and products
- No other technologies available to produce fungible liquid transportation fuels for national commerce and defense
- Investments in biofuels can be leveraged for broader application to bio-products and biopower

DOE Biomass Program Mission and Objectives



Program Mission

Convert renewable, non-food biomass resources into sustainable, cost-competitive, high-performance biofuels.

Focus on targeted research, development, and demonstration

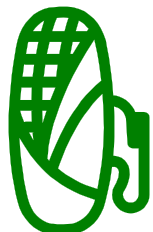
- Support through public and private partnerships
- Deploy in integrated biorefineries

Program Goals

- Modeled cellulosic ethanol cost competitive by 2012
- Support production of 21 billion gallons/year of advanced biofuels by 2022 (EISA)
- R&D to develop fungible, drop-in fuels and algal-based fuels



Successive Generations of Biofuels



Grain-based Ethanol

- Commercially available (no DOE research)
- Reduced GHG emissions
- Capacity constrained

DOE involvement only includes fuel blends testing, infrastructure development, and sustainability analysis.



Cellulosic Ethanol

- DOE research ongoing
- Potential to lower GHG emissions >80%
- Uses biomass from waste and non-agricultural land

Ongoing RD&D activities focus on multiple pathways to affordable and sustainable cellulosic ethanol from broad range of US biomass resources.



Other Advanced Biofuels

- Focus of newer DOE research
- Could minimize environmental footprint
- Energy density and chemistry similar to petroleum-based fuels

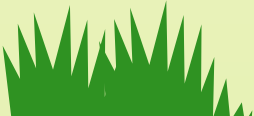
Includes DOE support to advanced, fungible (drop-in) fuels and algal-based biofuels R&D targeting gasoline, diesel, and jet fuel products.

Program Areas & Key Challenges



Research & Development

Demonstration & Deployment



Feedstock Systems

- Diverse regional biomass resources
- Yield & price
- Water & fertilizer
- Land use
- Metrics & standards

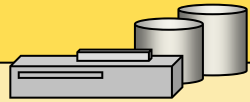
Conversion Technologies

Biochemical

- Cost & Efficiency
 - Pretreatments
 - Enzymes/yields
- Fermentation

Thermochemical

- Cost & Efficiency
- Gasification Process
- Fuel Stabilization



Integrated Biorefineries

- Integrating process technologies
- Financing
- Technical expertise
- Profit potential



Infrastructure

- Transport
- Storage
- Codes & Standards (Blend wall)
- Demand/markets
- Compatibility

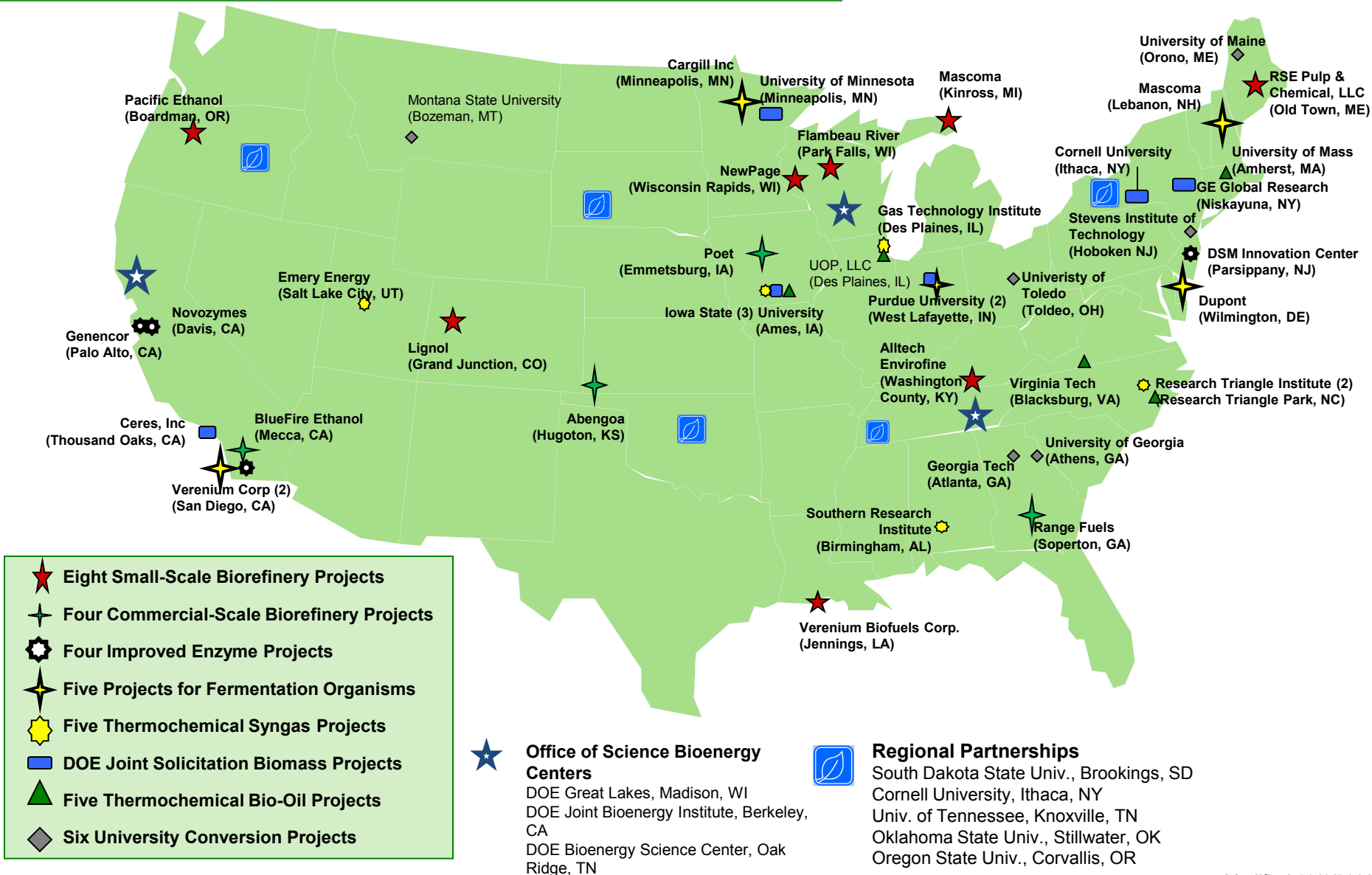
Product Development

- Fuel purity & cost
- By-products/markets
- Infrastructure compatibility

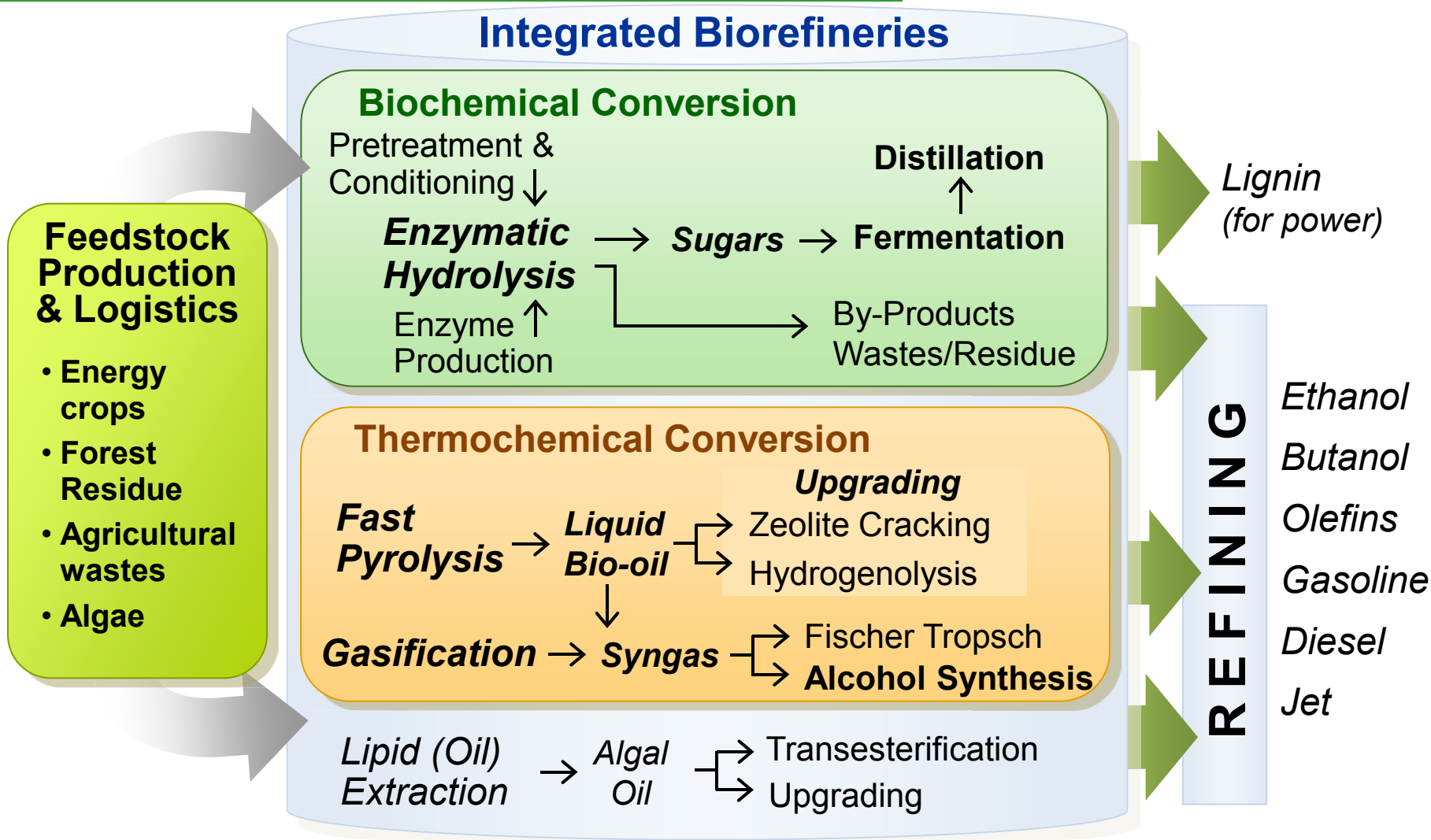
Sustainability

- GHG emissions
- Land use
- Predictive Modeling
- Water quality
- Socioeconomics
- International

Major DOE Biofuels Project Locations



Exploring Routes to Convert Biomass



Research on multiple conversion pathways aims to improve the efficiency and economics of biofuels production.

Distributed Pyrolysis and Centralized Bio-Oil Processing



Biomass

Pyrolysis

Stabilization

Deoxygenate

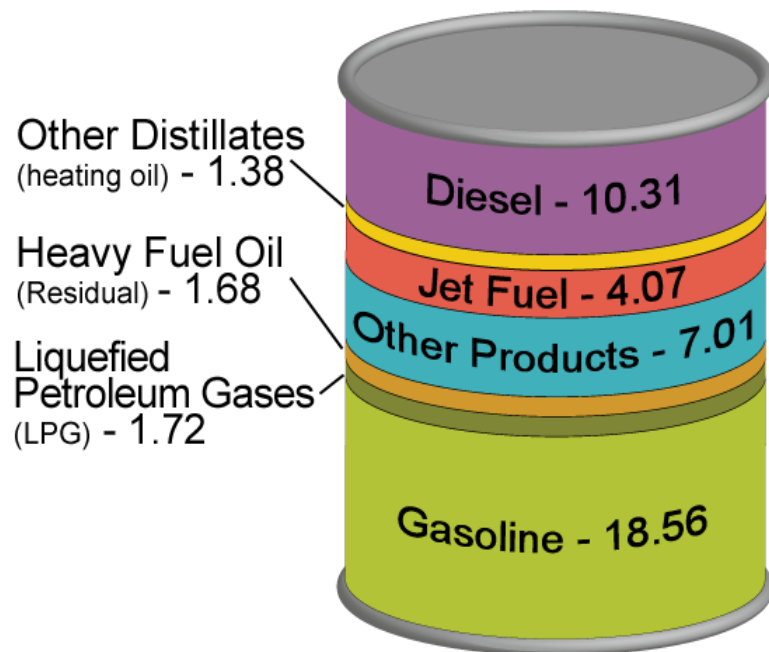
- Gasoline
- Diesel
- Jet
- Chemicals



Why Advanced Biofuels?



Products Made from a Barrel of Crude Oil (Gallons)



U.S. Diesel Outlook
(EIA AEO 2009 Reference Case for 2030)

- 75 billion gal/yr
- 0.5 billion gal/yr biodiesel production (2007)

U.S. Jet Fuel Outlook
(EIA AEO 2009 Reference Case for 2030)

- 31 billion gal/yr

- Cellulosic ethanol displaces light duty gasoline fraction only
- Heavy duty/diesel and jet fuel substitutes are needed to displace other components of the barrel

Infrastructure Compatible Advanced Biofuels



New research thrust is high energy density, infrastructure compatible biofuels

More similar in chemical makeup to existing hydrocarbon fuels

Compatible with the existing infrastructure

Suitable for use in heavy duty vehicles and aircraft



- Renewable gasoline
- Renewable diesel
- Renewable jet (e.g., JP-8)
- Cellulosic biobutanol
- Algae-derived biofuels

Infrastructure-Compatible
Advanced Biofuels



Recent DOE Awards for Algal and Advanced, Fungible Biofuels Consortia Address Gasoline, Diesel and Jet Markets



Donald Danforth Plant Center, lead institution

National Laboratories

- Los Alamos National Laboratory
- Pacific Northwest National Laboratory

Universities

- Brooklyn College
- Colorado State University
- New Mexico State University
- Texas AgriLife Research (TAMU)
- Texas A&M University System
- University of Arizona
- University of California Los Angeles
- University of California San Diego
- University of California Davis
- University of Washington
- Washington University, St. Louis
- Washington State University

Industries

- AXI
- Allied Minds
- Catilin
- Diversified Energy
- Eldorado Biofuels
- Genifuel
- HR Biopetroleum
- Inventure
- Kai BioEnergy
- Palmer Labs
- Pratt & Whitney
- Solix Biofuels
- Targeted Growth
- Terrabon
- UOP

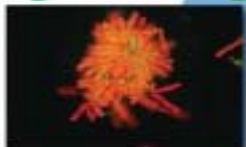
Subcontractors: Clarkson University, Center of Excellence for Hazardous Materials Management, Iowa State University, North Carolina State University, University of Pennsylvania, University of Texas

\$48.8M DOR Funding + \$20M Cost Share = \$68.8M over Three Years

National Alliance for Advanced Biofuels and Bioproducts



Algal Biology



Greater space-time lipid/algae yields

Cultivation



Harvesting and Extraction



Novel techniques to reduce cost and environmental impact



Valuable Coproducts



Livestock feed



Direct energy production



Chemicals for industry use

Fuel Conversion



High energy-density fungible fuels



CO₂



Water



Land



Nutrients

SUSTAINABILITY

Topic: Advanced, Fungible Biofuels

National Advanced Biofuels Consortium (NABC)



Led by: National Renewable Energy Laboratory
with: Pacific Northwest National Laboratory

Other National Laboratories

Argonne National Laboratory
Los Alamos National Laboratory

Universities

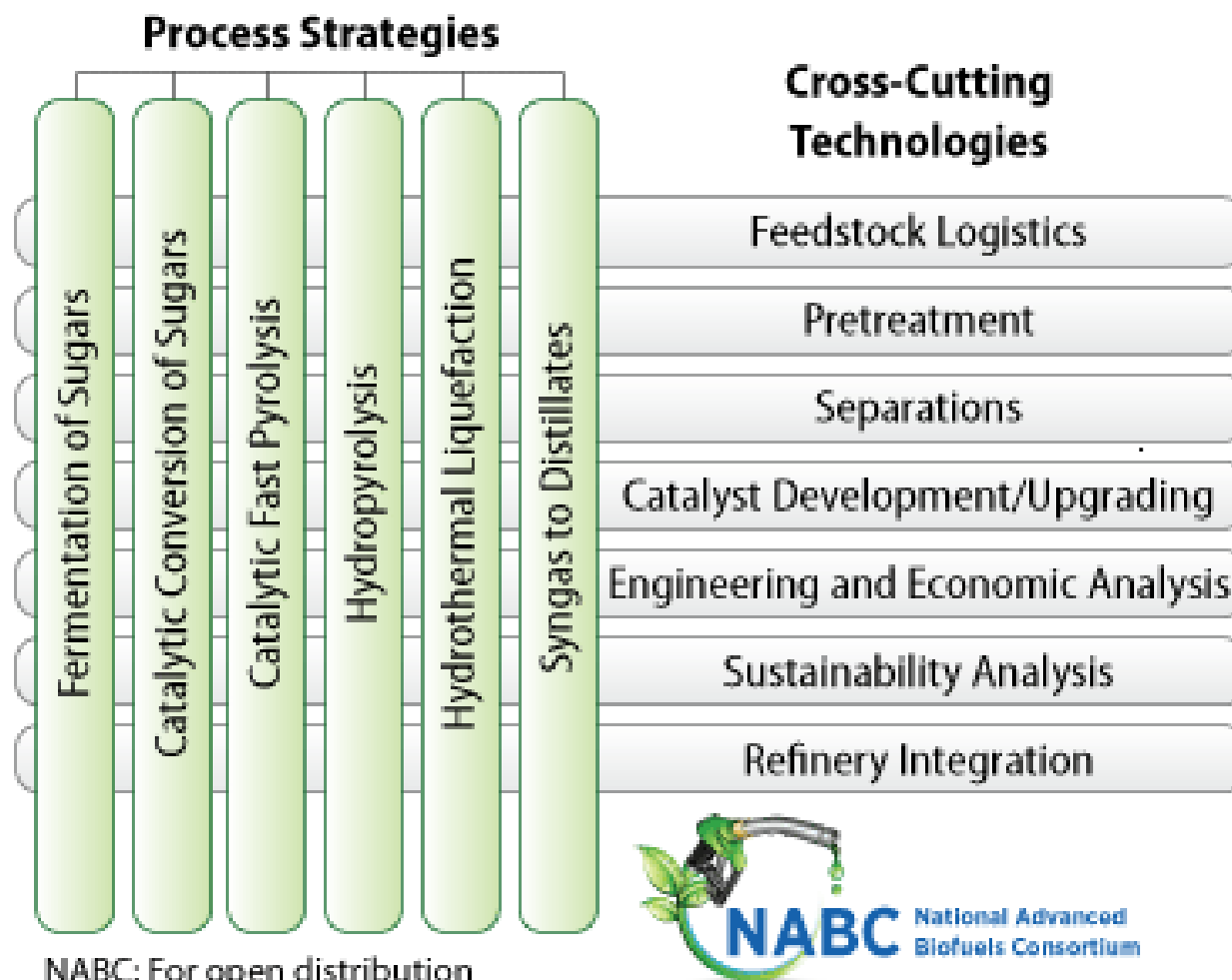
Colorado School of Mines
Iowa State University
University of California, Davis
Washington State University

Industries

Albemarle Corp.
Amyris Biotechnologies
BP Products North America Inc.
Catchlight Energy LLC
Pall Corp.
RTI International
Tesoro Companies Inc.
UOP LLC
Virent Energy Systems Inc.

\$33.8M DOE Funding + \$12M Cost Share, = \$45.8M over Three Years

National Advanced Biofuels Consortium





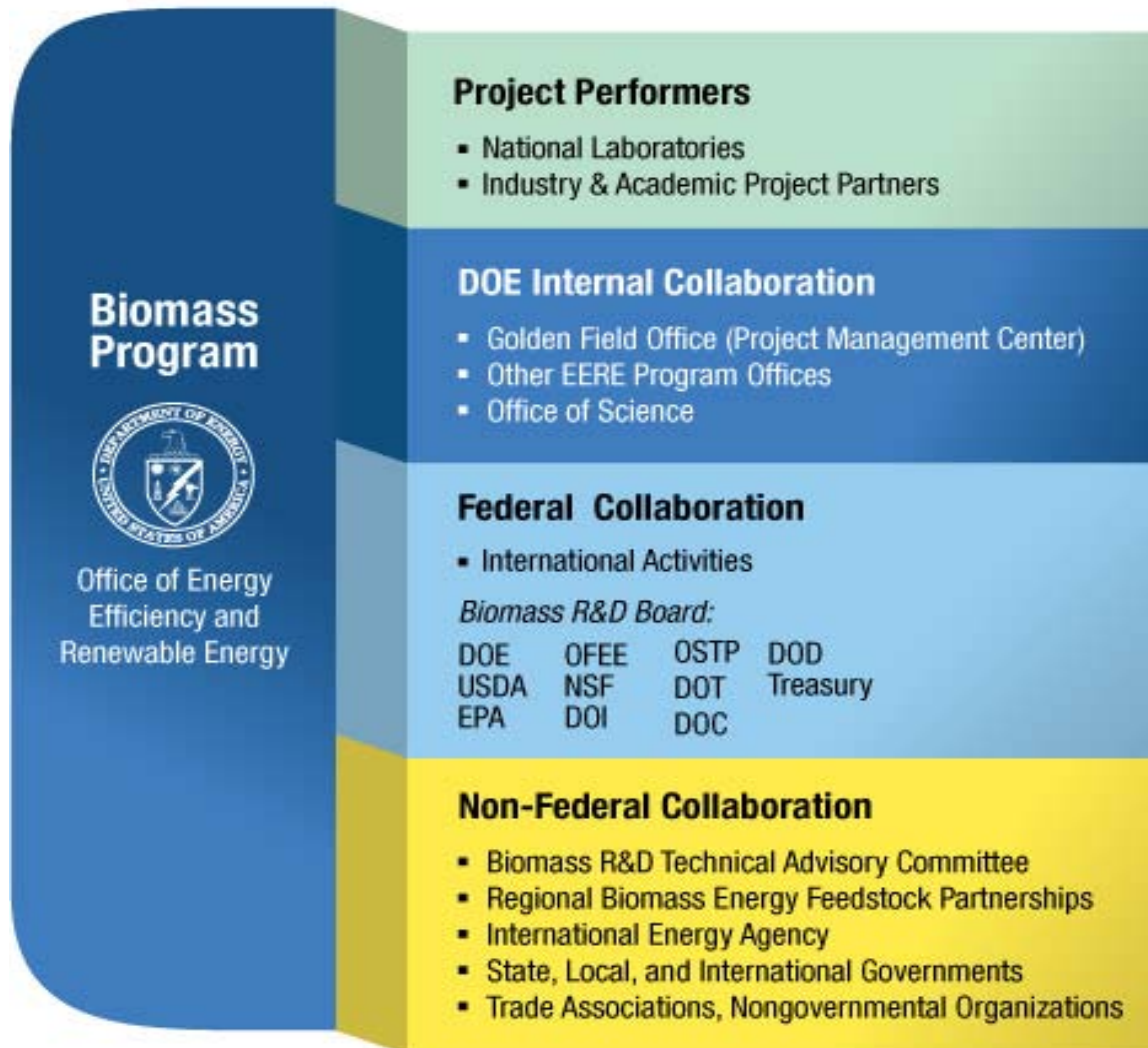
DOE is Actively Working to Coordinate Biofuels Efforts with Key Stakeholders

Key Stakeholder Relationships

Program Partners



Biomass Program Partners Organization Chart



Valri Lightner, Manager
Office of the Biomass Program
(202) 586-0937

<http://www.eere.energy.gov/biomass/>
<http://www.brdisolutions.gov/>

National laboratory partners:

National Renewable Energy Laboratory (NREL), DOE's Energy Efficiency and Renewable Energy Laboratory (www.nrel.gov)

Multi-program DOE labs:

Idaho National Laboratory (INL)

Oak Ridge National Laboratory (ORNL)

Argonne National Laboratory (ANL)

Pacific Northwest National Laboratory (PNNL)

Key Stakeholder Relationships

Biomass R&D Board



Charter and Leadership

- ▶ Mandated by Section 9001 of 2008 Food, Conservation, and Energy Act (FCEA) to:
 - Coordinate R&D on biofuels and biobased products
 - Departments of Agriculture and Energy
 - Other Federal departments and agencies
 - Ensure that annual [BRDi] solicitations are open and competitive, and solicitations requirements are clear, minimally prescriptive, and unbiased
 - Ensure review panels consist predominantly of independent experts from outside USDA and DOE
- ▶ Co-chaired by Presidential-appointed, Senate-confirmed officers from USDA and DOE, selected by the Secretaries of Agriculture and Energy, respectively.

Membership

Mostly Senate-confirmed sub-cabinet officials from 11 agencies



Co-chair



Co-chair



OFFICE OF THE FEDERAL
ENVIRONMENTAL EXECUTIVE



Thank you for the opportunity

A photograph of a misty or foggy landscape. In the foreground, a dirt path leads from the bottom left towards the center. To the left of the path is a large, dark evergreen tree. To the right is a dense field of green bushes. In the background, a line of tall, thin trees is visible through the fog. The text "Are there any questions?" is overlaid in blue on the upper part of the image.

Are there any questions?